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Pesticide Fact Sheet Number 131: Paraquat

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16. Abstract (Limit: 200 words)

This document contains up-to-date chemical information, including a summary of the Agency's regulatory position and rationale, on a specific pesticide or group of pesticides. A Fact Sheet is issued after one of the following actions has occurred.

1. Issuance or reissuance of a registration standard,
2. Issuance of each special review document,
3. Registration of a significantly changed use pattern,
4. Registration of a new chemical, or
5. An immediate need for information to resolve controversial issues relating to a specific chemical or use pattern.

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Pesticide Fact Sheet

Name of Chemical: Paraquat
Reason for Issuance: Registration Standard
Date Issued: JUN 18 1987
Fact Sheet Number: 131

1. Description of Chemical

Generic Name: 1,1'-dimethyl-4-4'-bipyridinium ion

Common Name: Paraquat

Trade Names: Actor Cekuquat, Crisquat, Dextrone, Dexuron, Esgram, Gramanol, Gramoxone, Gramuron, Hebaxon, Herboxone, Goldquat 276, Paracol Paraquat CL, Pillarquat, Pillarxone, Sweep, PP148 (dichloride) and Dextrone X.

EPA Shaughnessy Code: 061601 (dichloride)

Chemical Abstracts Service (CAS) Number: 1910-42-5 (dichloride)

Year of Initial Registration: 1964

Pesticide Type: Herbicide, defoliant, desiccant, and plant growth regulator

Chemical Family: Bipyridylnium or dipyridylnium

U.S. and Foreign Producers: ICI Americas, Inc.; Taiwan by Comlets Chemical Industrial Company, Ltd., and Shinung Corp., Italy by VisplantChrimiasero S.p.I.; Spain by Hightex S.A.; Great Britain by ICI Plant Protection Division.

2. Use Patterns and Formulations

Application Sites: Terrestrial food crops; terrestrial nonfood crops; terrestrial noncrop, forestry and domestic outdoor sites.

Major Crops Treated: Field crops (corn and soybeans), and fruit and nut crops.

Types and Method of Application: Foliarly applied by broadcast, band, or directed spray by ground equipment or broadcast by aircraft. It may be applied preplant, preemergence, or preharvest in relation to the crop.

Application Rates: 0.25 lb active ingredient/A to 1.0 lb active ingredient/A (0.28 to 1.12 kg active ingredient/ha).

Types of Formulation: Aqueous solution containing 2 lbs (0.24 kg) paraquat cation per gal (L).

Usual Carrier: Water.

3. Science Findings

Summary Science Statement: Paraquat is extremely toxic (Category I) via oral, dermal, and inhalation exposure routes to mammals. It is not teratogenic to mice or rats. Paraquat is not oncogenic to mice but is oncogenic to rats. Paraquat is weakly genotoxic - it was negative for mutagenicity in eight studies, weakly positive in four studies and positive in four studies.

Paraquat is moderately toxic to birds, slightly toxic to freshwater fish, moderately toxic to aquatic invertebrates, and relatively nontoxic to honeybees. Paraquat is not believed to cause problems with stable wildlife populations but may be hazardous to unstable or endangered populations of plants and animals.

Paraquat dichloride was stable to hydrolysis and photolysis in soil, preliminary data indicate that paraquat has a half-life of greater than 2 weeks in water plus soil, is immobile in silt loam and silty clay loam, and slightly mobile in sandy loam and potentially mobile in sandy soils extremely low in organic matter. The half-life of paraquat in water is approximately 23 weeks. Paraquat is not readily desorbed from the soil and is not likely to contaminate ground water in agricultural soils. Preliminary data indicate that the paraquat degradate ^{14}C-carboxy-1-methyl pyridinium (QINA) chloride is loosely absorbed in the soil and is potentially mobile and has a leaching potential.

Chemical Characteristics: Analytical grade of paraquat dichloride is a colorless odorless hygroscopic powder, whereas the technical product is yellow. Paraquat is very soluble in water, slightly soluble in alcohols and insoluble in hydrocarbons. It is nonvolatile, corrosive to metals, stable at room temperature (either as a solid or an aqueous solution at neutral or acidic pH), but is hydrolyzed by alkali, decomposes photochemically, and melts (with decomposition) at 300 °C.

Toxicology Characteristics:

Acute Toxicology

Acute Oral Toxicity (rat)	100 and 126 mg paraquat cation/kg for males; 112-150 mg paraquat cation/kg for females Toxicity Category II
Acute Oral Toxicity (guinea pig)	22 mg paraquat cation/kg for males and females Toxicity Category I
Acute Dermal Toxicity (rabbit)	59.9 mg paraquat cation/kg Toxicity Category I
Acute Inhalation (rat)	0.6 to 1.4 ug paraquat ion/L Toxicity Category I
Eye Irritation (rabbit)	Severe Eye Irritant Toxicity Category I
Primary Dermal Irritation (rabbit)	Primary irritation score of 2.1 - Toxicity Category III
Skin Sensitization (guinea pig)	Not a sensitizer

Major Routes of Exposure:

Acute Inhalation: Two inhalation studies were submitted. One study had an inhalation toxicity of about 1.0 ug/L (Toxicity Category I) with 90 percent of the particle diameters below 0.3 um. A second study was performed with particles of median diameter of 21.5 to 23 um. The inhalation toxicity for this study was 3.5 ug/L (Toxicity Category I). These studies show that inhalation toxicity is highly dependent on particle size.

Information received on particle size of paraquat droplets formed during aerial application and during knapsack spraying indicate that virtually no droplets smaller than 15 um were formed during either method of application.

Subchronic Dermal Exposure: A 21-day dermal toxicity study in rabbits was submitted with a NOEL of 1.15 mg paraquat cation/kg body weight (bwt) for local skin effects and a NOEL for systemic toxicity of 6 mg paraquat cation/kg bwt. Data are available indicating that a dermal absorption rate for humans is about 0.5 percent. These data are

preferable to dermal data from other species, therefore, the dermal data in rabbits are not of concern.

Combination of Acute Inhalation and Dermal Exposure: Margins of safety were calculated for combined inhalation and dermal exposure of workers repeatedly exposed to paraquat. Combined inhalation and dermal exposures of several groups of workers were then compared to a NOEL of 0.5 mg paraquat cation/kg/day derived from a 90-day dog-feeding study. The lowest effect level (LEL) for this study was 1.5 mg paraquat cation/kg/day, at which dosage level toxic effects in the lung were observed. All but two of the margins of safety are greater than 100.

Chronic Toxicology:

Teratology and Reproduction

Paraquat was not teratogenic to mice. The fetotoxic NOEL is 5 mg paraquat cation/kg bwt and the maternal NOEL is 1.0 mg paraquat cation/kg bwt.

Paraquat was not teratogenic to rats. Both the fetotoxic and maternal NOEL are 1.0 mg paraquat cation/kg bwt.

Paraquat had no effect on reproduction in rats. The systemic NOEL for reproduction is 25 parts per million (ppm).

The teratology and reproduction studies are acceptable and show no reason to place paraquat in Special Review.

Chronic Feeding - Oncogenic Studies

In the rat chronic feeding study, the systemic NOEL is 25 ppm of paraquat cation per kilogram of body weight and the systemic LEL is 75 ppm.

In the 1-year dog study the systemic NOEL is 15 ppm paraquat cation per kilogram of body weight. The systemic LEL is 30 ppm.

Paraquat was not oncogenic to mice. The systemic NOEL is 12.5 ppm of paraquat cation per kilogram of body weight. This study is acceptable.

Paraquat was oncogenic to rats. Squamous cell carcinoma occurred in 51.6 percent of all rats having tumors of the skin and subcutis in the head region. In high

dose males, the incidence was significantly increased over concurrent controls.

Mutagenicity: Paraquat was negative in eight studies (mostly in gene mutation and chromosomal aberration assays); weakly positive in two gene mutations, one chromosomal aberration and one DNA damage/repair assays; and positive in four DNA damage/repair assays.

Physiological and Biochemical Behavior Characteristics:

Foliar Absorption: Very rapidly absorbed by the foliage.

Translocation: Can occur via the xylem under certain conditions.

Mechanism of Pesticidal Action: Lipid peroxidation resulting in disruption of cell membrane.

Metabolism and Persistence in Plants: In sunlight, limited photochemical breakdown occurs for paraquat which remains on the outside of treated plants. Since plants are killed rapidly in bright sunlight, significant quantities of the breakdown products are formed only on surfaces of dead tissues and there is no movement of these substances from the dead tissues to other parts of the plant.

Environmental Characteristics:

Absorption and Leaching in Basic Soil Types: Langmuir adsorption maxima values (m) ranged from 17 to 46.8 mg/100 grams on seven clay soils and one silty clay loam soil. Adsorption is positively correlated with soil cation exchange capacity (CEC). Paraquat is not readily desorbed from the soil and is not likely to contaminate ground water in agricultural soils. Data are required to determine the potential for the QINA degradate to leach in soils.

Microbial Breakdown: Bound paraquat is degraded with difficulty or not at all.

Loss from Photodecomposition and/or Volatilization: Does not volatilize; limited photodecomposition may occur on sprayed leaf surfaces and dead vegetation.

Contamination of Ground and Surface Water: Paraquat binds tightly to the soil and does not leach in agricultural soils.

Exposure of Humans and Nontarget Organisms to Chemical or Degradates: Margins of safety for humans appear adequate when product is used according to label directions. Use of paraquat may have an effect on a few mammals or ground nesting birds under unusual circumstances. Wildlife populations should not be adversely affected when paraquat is used according to label directions.

Exposure During Reentry: Current precautionary labeling and worker safety rules adequately protect worker, mixer, loader, applicator.

Ecological Characteristics: Paraquat is moderately toxic to birds and aquatic invertebrates and slightly toxic to freshwater fish.

Avian Acute Oral Toxicity with Bobwhite quail: 176 mg/kg

Avian Dietary Toxicity with Bobwhite quail:	981 ppm
Ring-neck pheasant:	1468 ppm
Mallard duck:	4048 ppm

Avian Reproduction Studies: Bobwhite quail:	100 ppm
Mallard duck:	30 ppm

Acute Toxicology: Freshwater Fish:	
Rainbow trout:	15-38.7 ppm
Bluegill sunfish:	13-156 ppm

Acute Toxicity to Invertebrates (Daphnia): 1.2 to 4.0 mg/L

Endangered Species: Although paraquat is not believed to cause problems with stable wildlife populations, its acute and subacute toxicity may be hazardous to unstable or endangered populations (primarily plant species).

Tolerance Reassessment: Tolerances are established for residues of the plant regulator, desiccant, defoliant, and herbicide paraquat (1,1-dimethyl-4,4'-bipyridinium ion) derived from application of either the bis(methylsulfate) or dichloride salt (both calculated as the cation) in or on the following raw agricultural commodities (40 CFR 180.205):

Commodities	Parts Per Million
Acerola	0.05
Alfalfa	5.0
Almond hulls	0.5
Apples	0.05
Apricots	0.05
Asparagus	0.5
Avocados	0.05
Bananas	0.05
Barley, grain	0.05
Beans, forage	0.1
Beans, hay	0.4
Beans, lima (succulent)	0.05
Beans, snap (succulent)	0.05
Beets, sugar	0.5
Beets, sugar (tops)	0.5
Birdsfoot trefoil	5.0
Broccoli	0.05
Cabbage	0.05
Carrots	0.05
Cattle, fat	0.01
Cattle, meat	0.01
Cattle, meat byproducts	0.01
Cauliflower	0.05
Cherries	0.05
Chinese Cabbage	0.05
Citrus fruit	0.05
Clover	5.0
Coffee beans	0.05
Collards	0.05
Corn, fresh, inc. sweet corn (K + CWHR)	0.05
Corn, fodder	0.05
Corn forage	0.05
Corn grain	0.05
Cottonseed	0.5
Cucurbits	0.05
Eggs	0.01
Figs	0.05
Goats, fat	0.01
Goats, meat	0.01
Goats, meat byproducts	0.01
Grass, pasture	5.0
Grass, range	5.0
Guar beans	0.5
Guava	0.05
Hogs, fat	0.01
Hogs, meat	0.01
Hogs, meat byproducts	0.01
Hops, fresh	0.1

Commodities	Parts Per Million
Hops vines	0.5
Horses, fat	0.01
Horses, meat	0.01
Horses, meat byproducts	0.01
Kiwifruit	0.05
Lettuce	0.05
Milk	0.01
Mint, hay	0.5
Nectarines	0.05
Nuts	0.05
Oat grain	0.05
Olives	0.05
Onions, dry bulb	0.05
Onions, green	0.05
Papayas	0.05
Passion fruit	0.2
Peaches	0.05
Pears	0.05
Peas, succulent	0.05
Peas, hay	0.8
Pineapples	0.05
Pistachio nuts	0.05
Plums (fresh prunes)	0.05
Potatoes	0.5
Poultry, fat	0.01
Poultry, meat	0.01
Poultry, meat byproducts	0.01
Rhubarb	0.05
Rye grain	0.05
Safflower seed	0.05
Sheep, fat	0.01
Sheep, meat	0.01
Sheep, meat byproducts	0.01
Small fruit	0.05
Sorghum forage	0.05
Sorghum grain	0.05
Soybeans	0.05
Soybean forage	0.05
Strawberries	0.25
Sugarcane	0.5
Sunflower seeds	2.0
Turnips (roots)	0.05
Turnips (tops)	0.05
Vegetables, fruiting	0.05
Wheat grain	0.05

A food additive tolerance of 0.2 ppm is established for residues of the defoliant, desiccant, and herbicide paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) derived

from the application of either the bis(methylsulfate) or dichloride salt (both calculated as the cation) in or on dried hops resulting from application of the pesticide to growing hops (21 CFR 193.331).

Feed additive tolerances are established for residues of the defoliant, desiccant, and herbicide paraquat (1,1'dimethyl4-4'-bipyridinium ion) derived from the application of either the bis(methylsulfate) or dichloride salt (both calculated as the cation) in the following processed feeds when present therein as a result of application of paraquat to growing crops (21 CFR 561.289):

Feeds	Parts Per Million
Mint, hay, spent	3.0
Sunflower, seed, hulls	6.0

The acceptable daily intake (ADI) based on the 1-year dog study (NOEL of 0.45 mg/kg/day) and using a safety factor of 100 is calculated to be 0.0045 mg/kg/day. The maximum permitted intake (MPI) for a 60-kg human is calculated to be 0.27 mg/day. The theoretical maximum residue contribution (TMRC) for paraquat, based on published tolerances is 0.1134 mg/day. The TMRC constitutes 42 percent of the MPI.

Reported Pesticide Incidents: The Agency's Pesticide Incident Monitoring System (PIMS) indicated that the majority of the poisoning incidents involving paraquat resulted from the purposeful ingestion of the chemical in apparent suicide attempts.

4. Summary of Regulatory Position and Rationale

The Agency has classified paraquat as a Group C oncogen (Possible Human Carcinogen). However, after considering applicator exposure to paraquat, the Agency has concluded that the risks posed by paraquat are not of concern in terms of the magnitude of risk to the individual applicators.

The Agency is continuing to require that an emetic cleared under 40 CFR 180.1001 be incorporated into all manufacturing-use products (MUP's) and end-use products containing paraquat. The emetic is needed in the formulations to induce rapid vomiting thereby reducing absorption of paraquat if swallowed.

The Agency is requiring those agricultural products containing paraquat already classified as "Restricted Use" maintain this classification. Based on submitted acute toxicity and subchronic toxicity data the "Restricted Use" classification and current precautionary statements are necessary to protect mixer-loaders and applicators from effects of dermal toxicity.

The Agency has determined that the homeowner product containing 0.276 percent paraquat presently unrestricted will remain unrestricted. The Agency believes that this relatively dilute formulation, when used according to label directions, is not likely to present a significant health hazard to humans.

The Agency is requiring additional residue data on several crops and processed commodities as well as some changes in the tolerance listings. The Agency is requiring certain label revisions pertaining to application and grazing restrictions, as determined by review of available residue data.

The Agency is requiring labeling to protect endangered species. This labeling is addressed in Pesticide Registration (PR) Notices 87-4 and 87-5.

The Agency will issue registrations for substantially similar products while data gaps are being filled. Significant new uses for paraquat will be considered on a case-by-case basis.

5. Summary of Major Data Gaps

	Date due (from issuance of Standard)
Environmental fate data	9-50 months
Subchronic inhalation toxicity	15 months
Residue chemistry data	24 months
Product chemistry	6 months

6. Contact Person at EPA:

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